

Research article[urn:lsid:zoobank.org:pub:A23A8204-E5CB-45BA-B01A-7DC949743D1F](https://zoobank.org/pub:A23A8204-E5CB-45BA-B01A-7DC949743D1F)**Hitherto unknown and poorly known sexual morphs of three Asiatic species of the aphid genus *Uroleucon* (Hemiptera: Aphididae)****Mariusz Kanturski^{1,*} & Yerim Lee²**¹*Zoology Research Team, Institute of Biology, Biotechnology and Environmental Protection, Faculty of Natural Sciences, University of Silesia in Katowice, Bankowa 9, PL-40-007 Katowice, Poland*²*Insect Biosystematics Laboratory, Department of Agricultural Biotechnology, Seoul National University, Seoul 151-921, Republic of Korea***Corresponding author: Email: mariusz.kanturski@us.edu.pl*¹[urn:lsid:zoobank.org:author:78C290A3-D07B-4AF9-9358-ED8C05A702BF](https://zoobank.org/author:78C290A3-D07B-4AF9-9358-ED8C05A702BF)²[urn:lsid:zoobank.org:author:CC752515-8295-474E-B997-8EDF96C5D20B](https://zoobank.org/author:CC752515-8295-474E-B997-8EDF96C5D20B)

Abstract. In this paper, we describe hitherto unknown and redescribe poorly known sexual morphs (oviparous females and males) of three Asiatic species of the Macrosiphini genus *Uroleucon* Mordvilko, 1914. The oviparous female of *Uroleucon* (*Uromelan*) *amamianum* (Takahashi, 1930) is described in detail as well as the oviparous female and alate male of *U. (Uroleucon) fuchuense* (Shinji, 1942). The hitherto unknown oviparous female of *U. (U.) formosanum* (Takahashi, 1921) is described and the poorly known alate male is redescribed. Notes about distribution and host plants of these species are also given.

Key words. Aphids, description, *U. amamianum*, *U. formosanum*, *U. fuchuense*.

INTRODUCTION

Uroleucon Mordvilko, 1914 (Hemiptera: Aphididae: Macrosiphini), which comprises about 241 species within six subgenera, is regarded as one of the most speciose genus within the macrosiphines (Favret 2020). Members of *Uroleucon* are characterised by particularly often divergent antennal tubercles, apterous viviparous females with secondary rhinaria on the antennal segment III, quite a long terminal process and long and cylindrical siphunculi with a developed area of subapical reticulation. The cauda is often long and finger shaped, and the first segments of the tarsi usually have five, and in several species three or four setae. The abdomen of most *Uroleucon* species bears rounded or oval scleroites and quite long setae (Heie 1995; Blackman 2010; Blackman & Eastop 2020). More than 170 species live on herbaceous plants that belong to Asteraceae and Campanulaceae (Blackman 2010; Blackman & Eastop 2020). *Uroleucon* representatives have so far been described and recorded from almost all continents and zoogeographical regions including the East Palaearctic.

Apterous and alate viviparous females are the most well-known morphs of almost every species that has been described including *Uroleucon* in the East Palaearctic (e.g., Takahashi 1921; 1923; 1924; Miyazaki 1971; Pashchenko & Lobkova 1990; Pashchenko 2001). On

the other hand, in many cases, the sexual morphs (oviparous females and males) of many aphids are still poorly known or unknown, and have very rarely been collected and described. Despite this rarity, the importance of the sexual generation has been proven in the expansion of our knowledge of the general biology of poorly known species, but also by solving taxonomical problems or improving our understanding of the evolution of aphids (Ilharco 1965; Wieczorek et al. 2013; Depa et al. 2015; Pérez Hidalgo et al. 2016; Kanturski et al. 2017; Nowińska et al. 2017; Stekolshchikov & Buga 2017; Kanturski et al. 2018; Mier Durante et al. 2020).

In the Republic of Korea, a total of 20 species of *Uroleucon* have been recorded to date (Lee et al. 2002a; Lee et al. 2002b; Choi et al. 2012; Choi 2019). However, there has been little research on their sexual morphs. During an examination of the aphid collection in the Biology Centre of the Czech Academy of Sciences, Institute of Entomology, České Budějovice (Czech Republic), specimens of unknown and poorly known sexual morphs of three native East Palaearctic species of *Uroleucon* collected by the late J. Holman were discovered. We describe the oviparous female of *U. (Uromelan) amamianum* (Takahashi, 1930), the oviparous female and alate male of *U. (Uroleucon) fuchuense* (Shinji, 1941) and *U. (Uroleucon) formosanum* (Takahashi, 1921) and redescribe the poorly known alate male of the latter.

MATERIAL AND METHODS

The specimens were examined using a Leica DM 3000 LED light microscope and photographed using a Leica MC 190 HD camera using a differential interference contrast. The measurements were done according to Ilharco and van Harten (1987). The current host plant names are given according to The Plant List (2013).

The following abbreviations are used: ABD: abdominal tergite; ANT: antennae or their lengths; ANT I–VI: antennal segments I, II, III, IV, V, VI or their lengths (ratios between antennal segments are simply given as e.g. ‘VI: III’); BASE: basal part of last antennal segment or its length; BD III: basal articular diameter of ANT III; BL: body length (from the anterior border of the head to the end of cauda); III FEMORA: hind femora or their length; HW: greatest head width across the compound eyes; HT I: first segment of the hind tarsus; HT II: second segment of the hind tarsus or its length; LS ANT III: length of the longest setae of ANT III; PT: processus terminalis of the last antennal segment or its length; SIPH: siphunculus or its length; III TIBIAE: hind tibiae or their

length; URS: ultimate segments of the rostrum (IV + V) or their lengths. In the case of a series of single slides with a single specimen with the same collection data for the examined material sections, all of them present the same data as the full previous slide in order to avoid repetition. The terminology of the male genitalia follows Wieczorek et al. (2011). The photos of apterous viviparous females of *U. formosanum* in Figure 6a and 6b are used with permission of JADAM Organic Farming, <http://en.jadam.kr/news/articleView.html?idxno=10121> (Daejeon, Republic of Korea)

The material examined is deposited in IECA — the Biology Centre of the Czech Academy of Sciences, Institute of Entomology, České Budějovice (Czech Republic);

RESULTS

Uroleucon (Uromelan) amamianum (Takahashi, 1930)
Figs 1–2

Macrosiphum amamianum Takahashi, 1930: 318



Fig. 1. Oviparous female of *Uroleucon amamianum*.

Dactynotus amamianus Takahashi, 1962: 76

Uroleucon (*Uromelan*) *amamianum* Eastop & Hille Ris Lambers, 1976: 255

The apterous viviparous females of this species are bright shiny red to reddish brown with black antennae, siphunculi, cauda and distal halves of the femora (Takahashi 1930; Blackman & Eastop 2020). According to Miyazaki (1971), *Uroleucon amamianum* is similar to *U. lactucico-*

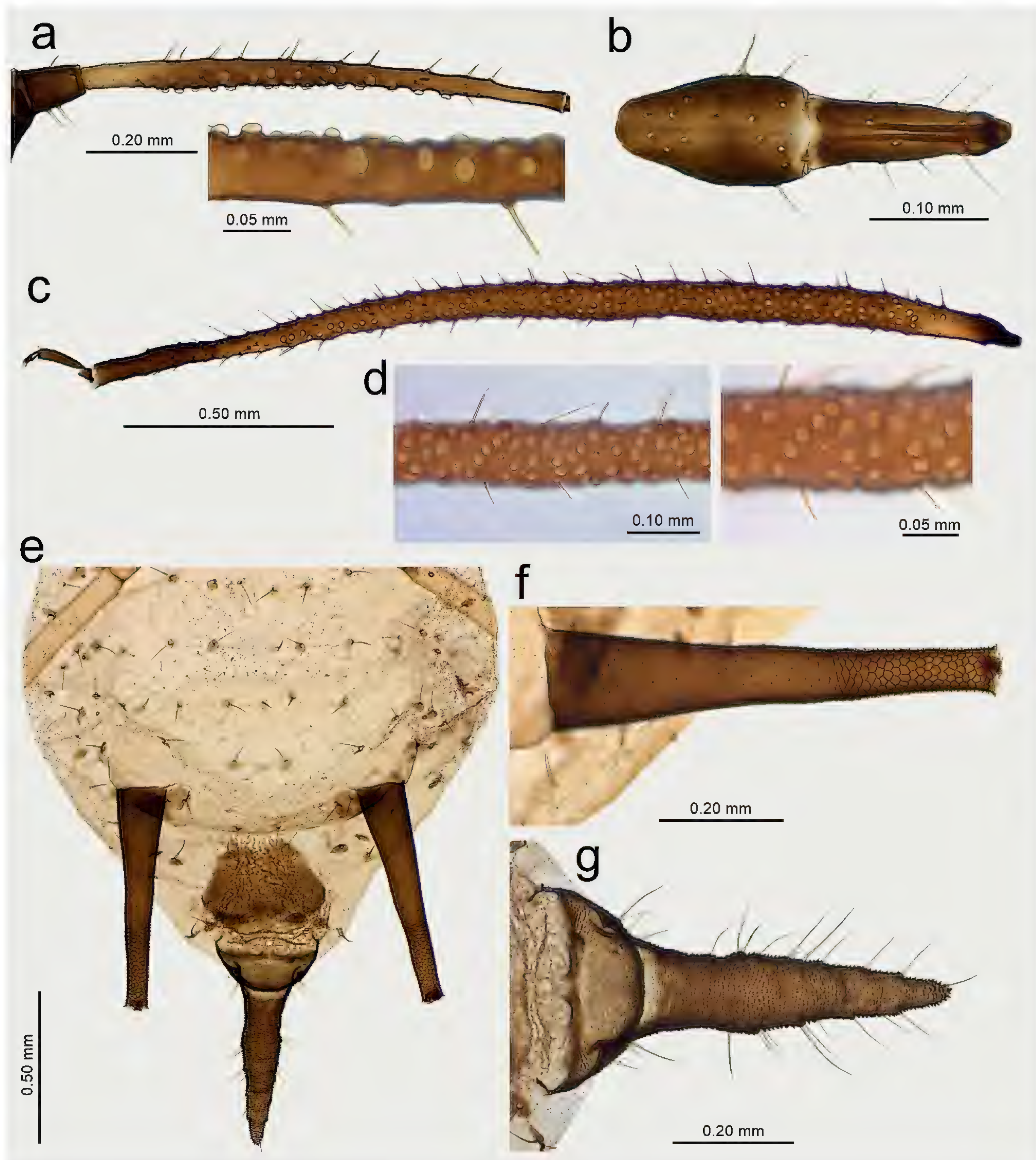


Fig. 2. Oviparous female of *Uroleucon amamianum*, morphological details. **a.** ANT III secondary rhinaria. **b.** Third and ultimate rostral segments. **c.** Hind tibia with scent plaques distribution. **d.** Scent plaques, detailed view. **e.** Abdomen. **f.** Siphunculus. **g.** Cauda.

la (Strand, 1928) due to the rather small and flat primary rhinarium on ANT V but differs in the ratio of the SIPH/cauda, which is less than 1.33 in the apterous viviparous females. This is quite a poorly known species, which as yet is only known from Japan and Korea. Miyazaki (1971) collected many apterous and alate viviparous females mostly from *Solidago virga-aurea* and *Aster* sp. in Japan. In The Republic of Korea, the species was recorded for the first time by Lee et al. (2002a), and was later reviewed with other species of the genus *Uromelan* by Choi et al. (2012), which found it on *Aster pinnatifidus*, *A. maackii*, *Patrinia scabionsaeifolia*, *Picris hieracioides*, *Solidago virga-aurea* var. *asiatica* and *S. virga-aurea* var. *gigantus*. Choi (2019) redescribed the apterous and alate viviparous female but no sexual morphs were included.

Oviparous female – description (n = 10)

Figs 1–2

Colour in life. Unknown. Pigmentation on slide: head brown; ANT I–II dark brown; ANT III brown with paler bases and sometimes with paler distal end; ANT IV–VI brown; pronotum and mesonotum usually with sclerotisation, brown; femora yellow with brown to dark brown distal halves; fore and middle tibiae with yellow middle section and dark brown bases and apices; hind tibiae brown to dark brown, sometimes with slightly paler sections near the proximal and distal ends but the very ends are always dark brown; tarsi dark brown; abdomen yellow with brown sclerites and scleroites; SIPH uniformly dark brown, cauda dark brown (Fig. 1).

BL 3.10–3.42 mm. HW 0.57–0.59 mm, $0.15\text{--}0.16 \times \text{ANT}$. Head with long, rigid setae with mostly pointed apices, 0.075–0.110 mm long. ANT tubercles each with 2–3 setae on internal angles. ANT 3.44–3.66 mm, $1.03\text{--}1.17 \times \text{BL}$. ANT III 0.81–0.87 mm with 27–38 protuberant, rounded or oval, different-sized secondary rhinaria with sclerotised rims, 0.01–0.02 mm in diameter (Fig. 2a), ANT IV 0.63–0.67 mm, ANT V 0.56–0.60 mm. ANT VI 1.14–1.27 mm, BASE 0.19–0.21 mm, PT 0.95–1.08 mm, $4.57\text{--}5.68 \times \text{BASE}$. Other antennal ratios: VI:III 1.37–1.49, V:III 0.67–0.69, IV:III 0.75–0.77, PT:III 1.12–1.27, PT:IV 1.50–1.63, PT:V 1.65–1.89. ANT chaetotaxy: ANT have thick, rigid setae with slightly blunt or narrow capitate apices. ANT III setae 0.03–0.05 mm long, LS ANT III $1.12\text{--}1.25 \times \text{BD III}$. ANT I with 10–11, ANT II with 4, ANT III with 20–26, ANT IV with 12–14, ANT V with 8–12 setae. ANT VI with 2–3 basal, 3–4 apical and 4–6 setae along the PT. Rostrum reaching hind coxae. URS 0.16–0.17 mm, $0.18\text{--}0.20 \times \text{ANT III}$, $0.12\text{--}0.14 \times \text{ANT VI}$, $0.14\text{--}0.17 \times \text{PT}$, $0.80\text{--}0.89 \times \text{BASE}$ and $1.30\text{--}1.36 \times \text{HT II}$ with 8–9 fine, pointed accessory setae (Fig. 2b). Mesosternal furca fused, wide, without stem. III FEMORA 1.22–1.25 mm with medium-length to long, stiff, rigid setae with pointed or slightly blunt apices, 0.020–0.05 mm long. III TIB-

IAE 2.17–2.25 mm, swollen with large number (c. 300–330) of rounded to oval or some 8-shaped scent plaques (pseudosensoria) on entire area and length (besides the very ends) (Fig. 2c–d). Setae on III TIBIAE rigid with mostly pointed or slightly blunt apices, 0.020–0.085 mm long. HT I with 3:3:3 setae, HT II 0.12–0.13 mm, $0.14\text{--}0.15 \times \text{ANT III}$, $0.09\text{--}0.11 \times \text{ANT VI}$, $0.11\text{--}0.13 \times \text{PT}$ and $0.61\text{--}0.65 \times \text{BASE}$. Abdomen membranous, with well-visible, rounded and irregular scleroites in spinal, dorsal and marginal areas (Fig. 2e), without marginal tubercles with medium-length to long, thick, rigid setae with pointed or slightly blunt apices, 0.055–0.110 mm long on ABD TERG I–V and 0.070–0.120 mm long on ABD TERG VI–VIII. ABD VIII with 8–9 setae. SIPH 0.67–0.70 mm, tubular, tapering, straight with distinct zone of subapical reticulation, well-developed postsiphuncular sclerites and small flange (Fig. 2f). Reticulated zone $0.31\text{--}0.37 \times \text{SIPH}$. SIPH $1.22\text{--}1.40 \times \text{cauda}$, $0.20\text{--}0.21 \times \text{BL}$ and $0.79\text{--}0.82 \times \text{ANT III}$. Genital plate with 2–3 anterior, 6–12 median and 28–29 posterior setae. Cauda 0.49–0.57 mm long and 0.19–0.22 mm wide, tapering, slightly constricted near base, $2.27\text{--}3.00 \times$ its width at base and $0.15\text{--}0.16 \times \text{BL}$ with 22–26 fine, pointed setae of two lengths (Fig. 2g).

Material examined. REPUBLIC OF KOREA, Gyeonggi-do, Pocheon-si, Gwangneung Royal Tomb Arboretum, Dendrological Park, 19 October 2000, *Solidago virgaurea*, J. Holman leg., 1 oviparous female, 1 apterous viviparous female, 00Ho75 (ovipara 9–10) (IECA), 2 oviparous females, 00Ho75 (ovipara 19–20), 2 oviparous females, 00Ho75 (ovipara 21–22), 1 oviparous female, 1 apterous viviparous female 00Ho75 (ovipara 23–24), 2 oviparous females, 00Ho75 (ovipara 25–26), 2 oviparous females, 00Ho75 (ovipara 27–28).

Uroleucon (Uroleucon) formosanum (Takahashi, 1921) Figs 3–6

Macrosiphum formosanum Takahashi, 1921: 6

Dactynotus (Dactynotus) formosanus Takahashi, 1962: 74

Uroleucon formosana Ghosh et al. 170: 390

This species is one of the most commonly recorded *Uroleucon* in Eastern Asia, feeds mostly on species of *Lactuca*, *Ixeris*, *Picris*, *Sonchus* and others (Higuchi & Miyazaki 1969; Holman 2009) and can be easily recognised by its very long ANT III (in comparison to ANT IV and V) and large and extremely protuberant secondary rhinaria. Apterous viviparous females are shining red-brown with a broad black patch on the proximal part of the abdomen, black siphunculi and a pale yellow cauda (Fig. 3a–b). Alate viviparous females are similar in colour, with dark dorsal side of thorax and darker ventral side of abdomen (Fig. 3c). The species was described from Taiwan based

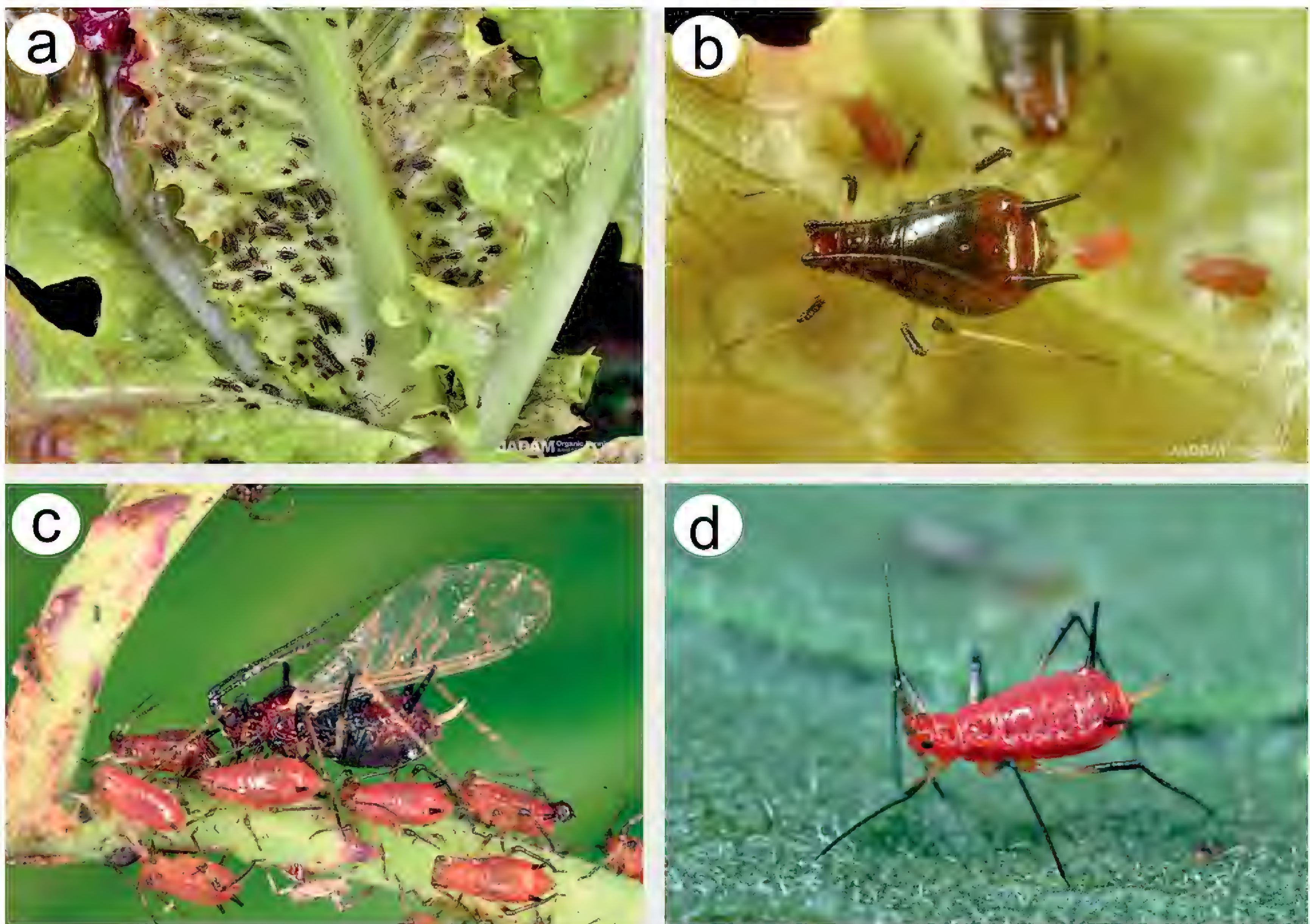


Fig. 3. *Uroleucon formosanum* viviparous generation on *Lactuca* and *U. fuchuense* in Korea. **a.** Colony of apterous viviparous females and larvae of *U. formosanum*. **b.** Apterous viviparous female of *U. formosanum* colour. **c.** Alate viviparous female of *U. formosanum* colour **d.** Apterous viviparous female of *U. fuchuense* colour.

on the viviparous generation (Takahashi 1921). In the same paper, Takahashi gave information that in November sexual morphs were observed near Tokyo in Japan, but not in Taiwan. Later, Takahashi provided information that the alate males and oviparous females occur in Japan from the last part of October until the end of November, whereas near Taihoku, the viviparous generations were observed throughout the year (Takahashi 1923). Shinji (1941) redescribed the viviparous generation and gave only a brief description of the alate male but as his monograph is in Japanese, the information was not available for a broad group of researchers. As for the occurrence, besides Taiwan (Takahashi 1921, 1923, 1924), the Korean Peninsula (Okamoto & Takahashi 1927; Lee et al. 2002b; Choi 2019; Choi et al. 2019) and Japan (Takahashi 1921; Shinji 1941; Miyazaki 1971; Sorin 1992; Sorin & Arakawa 2005; Adachi & Yoshitomi 2012, 2013; Yoshitomi 2014a, b, 2015), *U. formosanum* is known from China (Lou 1935; Tao 1963, 1968), India (Ghosh et al. 1970), Russian Far East (Pashchenko 1988, 2000) and Vietnam (Szelegiewicz 1968) in Asia. The species has been also recorded from Mariana Islands (Microne-

sia) which belong to the USA (Miller et al. 2003). Pike et al. (2005) provided a detailed redescription of the apterous and alate viviparous female during the comparison with *U. sonchellum* but the sexual generation was still not included.

Oviparous female – description (n = 9)

Figs 4–5

Colour in life. very similar to the apterous viviparous female (Shinji 1941). Pigmentation on slide: head and thorax dark brown; ANT uniformly brown to dark brown with sometimes slightly paler distal parts of ANT IV and ANT V; femora yellow with dark brown distal halves; fore and middle tibiae yellow middle sections and dark brown proximal and distal ends; hind tibiae brown with slightly paler distal half and dark brown proximal and distal ends; tarsi dark brown; abdomen yellow with brown sclerites and scleroites; SIPH uniformly dark brown, cauda yellow or pale (Fig. 4a).

BL 2.77–3.57 mm. HW 0.50–0.55 mm, $0.14\text{--}0.17 \times \text{ANT}$. Head with medium-length, fine, rigid setae

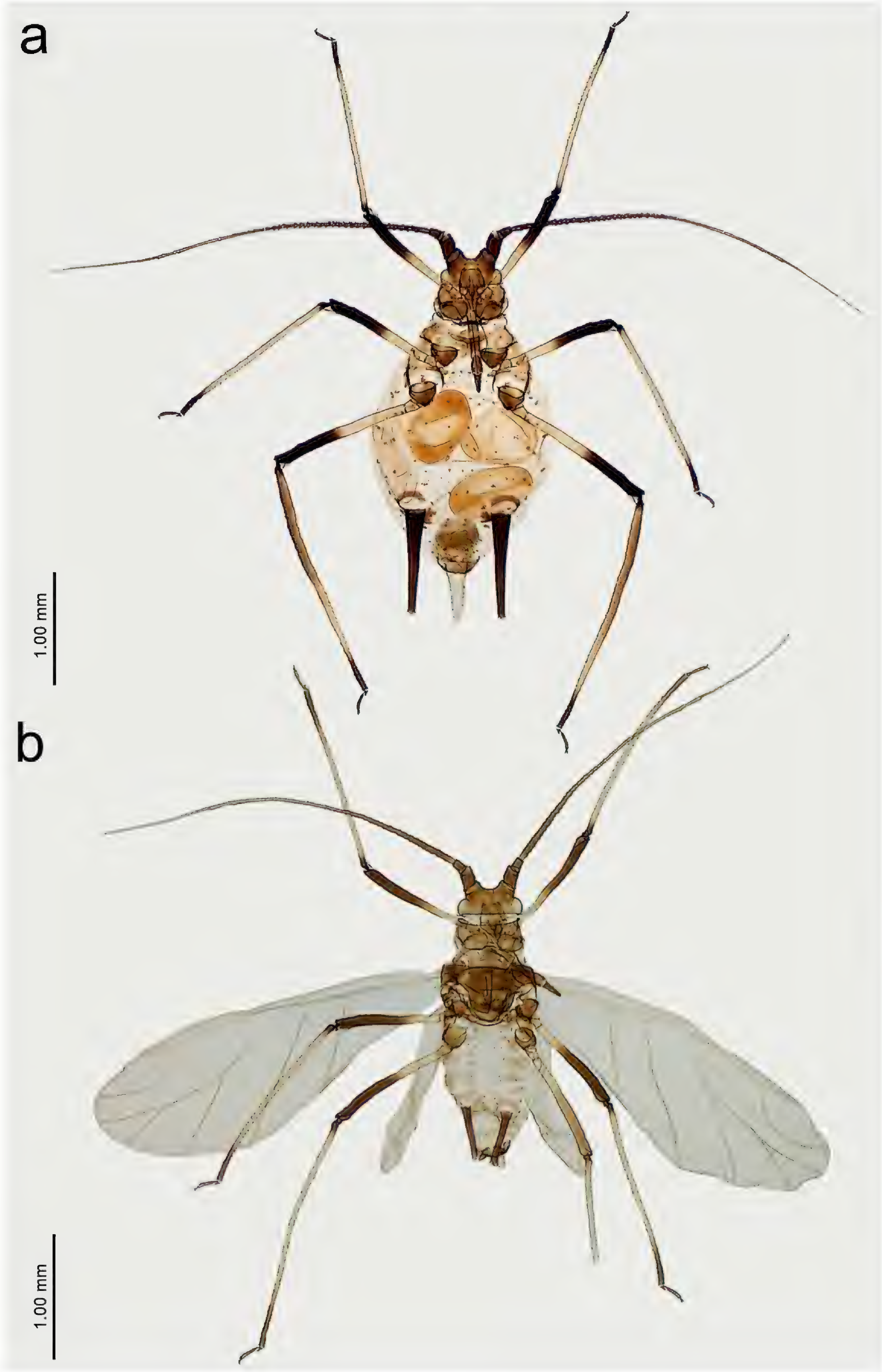


Fig. 4. Sexual morphs of *Uroleucon formosanum*. **a.** Oviparous female. **b.** Alate male.

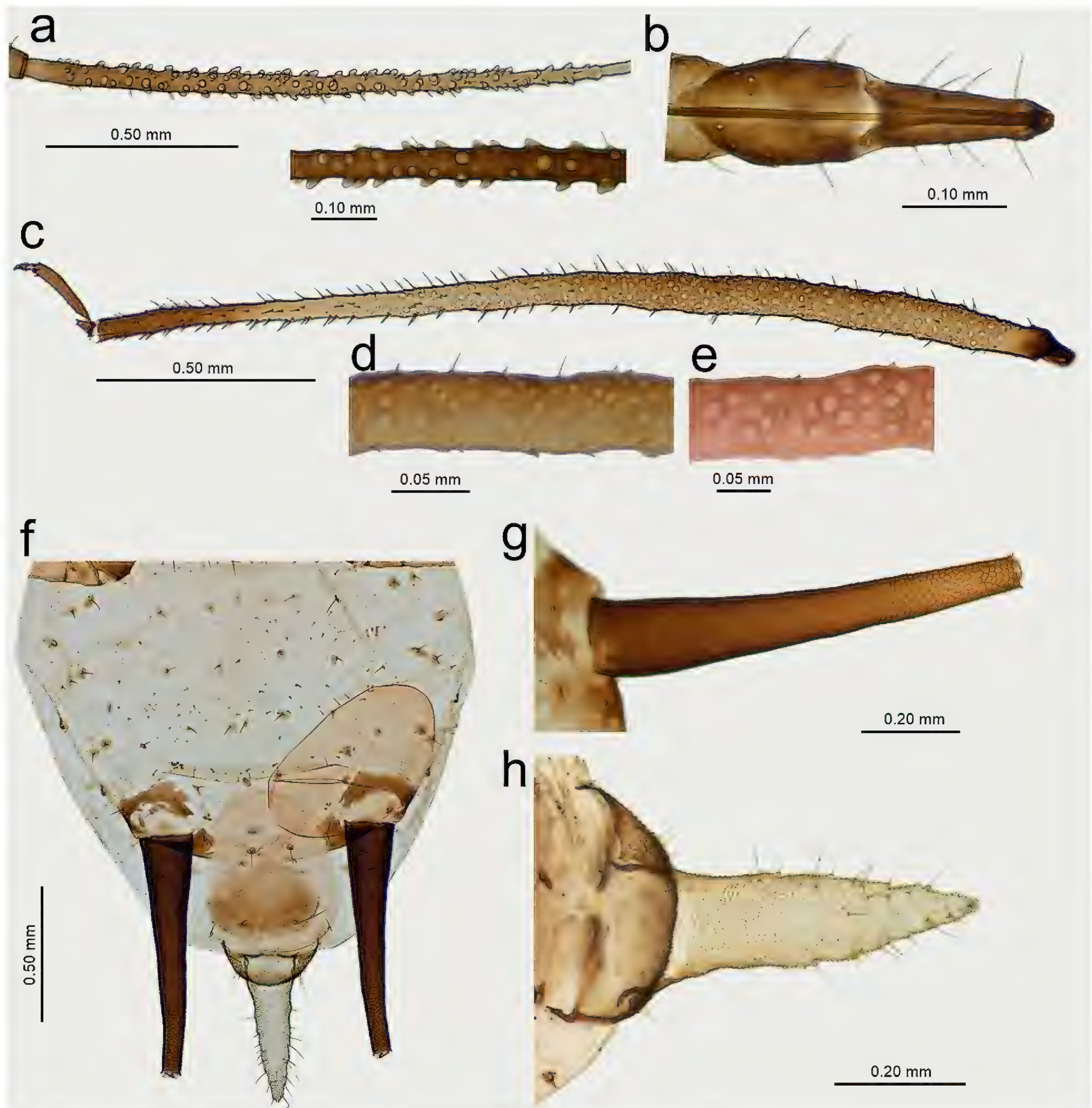


Fig. 5. Oviparous female of *Uroleucon formosanum*, morphological details. **a.** ANT III secondary rhinaria. **b.** Third and ultimate rostral segments. **c.** Hind tibia with scent plaques distribution. **d–e.** Scent plaques, detailed view. **f.** Abdomen. **g.** Siphunculus. **h.** Cauda.

with mostly pointed apices, 0.035–0.070 mm long. ANT tubercles each with 2–3 setae on internal angles. ANT 2.93–3.73 mm, $1.04\text{--}1.09 \times \text{BL}$. ANT III very long, 1.15–1.57 mm, with 78–110 mostly rounded and oval, different-sized and extremely protuberant secondary rhinaria, without sclerotised rims (Fig. 5a), ANT IV 0.31–0.41 mm, ANT V 0.30–0.41 mm. ANT VI 0.89–1.07 mm, BASE 0.12–0.16 mm, PT 0.77–0.92 mm, $5.56\text{--}6.41 \times \text{BASE}$. Other antennal ratios: VI:III 0.66–0.77, V:III 0.24–0.27,

IV:III 0.25–0.26, PT:III 0.56–0.66, PT:IV 2.22–2.56, PT:V 2.24–2.56. ANT chaetotaxy: ANT bearing thick, rigid setae with mostly pointed or slightly blunt apices. ANT III setae 0.020–0.035 mm long, LS ANT III $0.62\text{--}0.87 \times \text{BD III}$. ANT I with 6–7, ANT II with 4, ANT III with 18–26, ANT IV with 5–6, ANT V with 5–7 setae. ANT VI with 3–4 basal, 4 apical and 4–5 setae along the PT. Rostrum reaching hind coxae. URS 0.17 mm, $0.10\text{--}0.14 \times \text{ANT III}$, $0.15\text{--}0.19 \times \text{ANT VI}$, $0.18\text{--}0.22 \times \text{PT}$,

1.06–1.41 $\times$ BASE and 0.94–1.03 $\times$ HT II, with 8–9 short, fine, pointed accessory setae (Fig. 5b). Mesosternal furca fused, wide and robust, without or with poorly-developed and very stem. III FEMORA 1.05–1.30 mm, bearing medium-length to long, thick, rigid setae with mostly pointed or slightly blunt apices, 0.020–0.045 mm long. III TIBIAE 1.87–2.30 mm, swollen in the proximal part with large number (c. 313–343) of mostly rounded or slightly irregular scent plaques (pseudosensoria) on the entire area and length (besides the very ends) (Fig. 5c–e). III TIBIAE bearing rigid setae with mostly slightly pointed apices, 0.020–0.055 mm long. HT I with 5:5:5 ventral setae, HT II 0.16–0.18 mm, 0.11–0.14 $\times$ ANT III, 0.16–0.18 $\times$ ANT VI, 0.19–0.21 $\times$ PT and 1.12–1.37 $\times$ BASE. Abdomen membranous, with small but well-visible, rounded or irregular sclerites in spinal, dorsal and marginal area, without marginal tubercles, with medium-length to long, rigid setae with pointed apices, 0.035–0.075 mm long on ABD TERG I–V and 0.040–0.085 mm long on ABD TERG VI–VIII. SIPH with well-developed antesiphuncular and postsiphuncular sclerites (Fig. 5f). SIPH 0.67–0.90 mm, tubular, tapering, rather straight, with distinct zone of subapical reticulation and flange (Fig. 5g). The reticulated zone 0.24–0.29 $\times$ SIPH. SIPH 1.26–1.69 $\times$ cauda, 0.24–0.26 $\times$ BL, and 0.54–0.60 $\times$ ANT III. Genital plate with two anterior setae that are longer than the others, 8–14 median and 18–21 posterior setae. Cauda finger-shaped, 0.53–0.55 mm, long and 0.17–0.22 mm wide, 2.40–3.11 $\times$ its width at base and 0.15–0.19 $\times$ BL, with 26–28 fine setae of two lengths (Fig. 5h).

Alate male – redescription (n = 4)

Figs 4, 6

Colour in life. Unknown. Pigmentation on slide: head and thorax brown; ANT brown except basal part of ANT III and ANT VI PT which are paler; coxae brown; femora brown with yellow proximal parts or halves; tibiae with yellow middle section and brown apices; tarsi brown; SIPH brown; cauda pale (Fig. 4b).

BL 2.07–2.55 mm. HW 0.44–0.48 mm, 0.16–0.17 $\times$ ANT. Head with fine, rigid setae with pointed apices, 0.025–0.040 mm long. ANT tubercles each with 3–4 setae on internal angles. ANT 2.58–3.00 mm, 1.17–1.30 $\times$ BL. ANT III long, 0.91–1.05 mm, with 56–80 mostly rounded, different-sized, secondary rhinaria with sclerotised rims located on the whole length and surface (Fig. 6a–b), ANT IV 0.28–0.37 mm, with only 3–5 secondary rhinaria (Fig. 6c). ANT V, 0.29–0.39 mm, with 5–13 secondary rhinaria (Fig. 6d). Primary rhinaria rims on ANT V and VI with delicate projections (Fig. 6e, f). ANT VI 0.88–1.01 mm, BASE 0.12–0.15 mm, PT 0.76–0.86 mm, 5.64–6.33 $\times$ BASE. Other antennal ratios: VI:III 0.88–1.01, V:III 0.31–0.37, IV:III 0.30–0.37, PT:III 0.75–0.86, PT:IV 2.19–2.71, PT:V 2.25–2.62. ANT has short, thick, rigid setae with slightly pointed

or blunt apices. ANT III setae 0.015–0.030 mm long, LS ANT III 0.71–0.83 $\times$ BD III. ANT I with 46–7, ANT II with 4, ANT III with 22–26, ANT IV with 7, ANT V with 6–8 setae. ANT VI with 3–4 basal, 4 apical and 4–5 setae along the PT. Rostrum reaching metasternum. URS 0.14–0.16 mm, 0.14–0.16 $\times$ ANT III, 0.15–0.16 $\times$ ANT VI, 0.18–0.19 $\times$ PT, 1.06–1.20 $\times$ BASE and 0.93–1.06 $\times$ HT II, with 7–8 fine, pointed accessory setae (Fig. 6g). III FEMORA 0.83–0.92 mm, with short to medium-length, thick, rigid setae with pointed or blunt apices, 0.012–0.035 mm long. III TIBIAE 1.45–1.82 mm, have thick, rigid setae with mostly pointed or blunt apices, 0.004–0.045 mm long. HT I with 5:5:5 ventral setae, HT II 0.14–0.16 mm, 0.15 $\times$ ANT III, 0.14–0.17 $\times$ ANT VI, 0.10–0.20 $\times$ PT and 1.00–1.16 $\times$ BASE. Abdomen membranous, with rounded or oval sclerites, without marginal tubercles with medium-length, fine setae with pointed apices, 0.020–0.055 mm long on ABD TERG I–V and 0.025–0.060 mm long on ABD TERG VI–VIII. ABD VIII with 4 setae. SIPH with ante- and postsiphuncular sclerites (Fig. 6h). SIPH 0.30–0.41 mm, tubular, slightly tapering, straight with distinct zone of subapical reticulation and flange (Fig. 6i). Reticulated zone 0.24–0.26 $\times$ SIPH. SIPH 1.30–2.00 $\times$ cauda, 0.14–0.17 $\times$ BL, and 0.32–0.41 $\times$ ANT III. Cauda long-triangular, 0.20–0.25 mm long and 0.10–0.14 mm wide, without constriction, 1.42–2.30 $\times$ its width at base and 0.08–0.11 $\times$ BL with 11–12 fine setae of two lengths. Parameres triangular in ventral, flattened in ventrolateral side with rounded tips covered with numerous short, fine, pointed setae. Basal part of phallus as long as or slightly longer than parameres with numerous sensilla (Fig. 6j).

Material examined. REPUBLIC OF KOREA, Gyeonggi-do, Suwon-si, Seoul National University campus, 15 October 2000, *Picris hieracloides glabrescens*, J. Holman leg., 1 alate male, 00Ho33 (IECA); *Ixeris dentata*, 2 alate males, 00Ho25 (IECA); RDA (Yogi-San), 05 October 2000, *I. dentata*, J. Holman leg., 1 alate male, 00Ho01 (IECA); Gyeonggi-do, Suwon-si, NIAST, (Mt. Yeogi-San), 05 October 2000, *I. dentata*, J. Holman leg., 2 oviparous females, 00Ho01 (ovipara 1-2) (IECA), 2 oviparous females 00Ho01 (ovipara 3-4) (IECA), 1 apterous viviparous female, 2 oviparous females 00Ho01 (ovipara 5-7) (IECA); Gyeonggi-do, Suwon-si, Seoul National University campus, 15 October 2000, *P. hieracioidea glabrescens*, J. Holman leg., 2 oviparous females, 00Ho33 (ovipara 4-5) (IECA), 1 apterous viviparous female, 1 oviparous female, 00Ho33 (apt. 3+ovipara 1) (IECA).

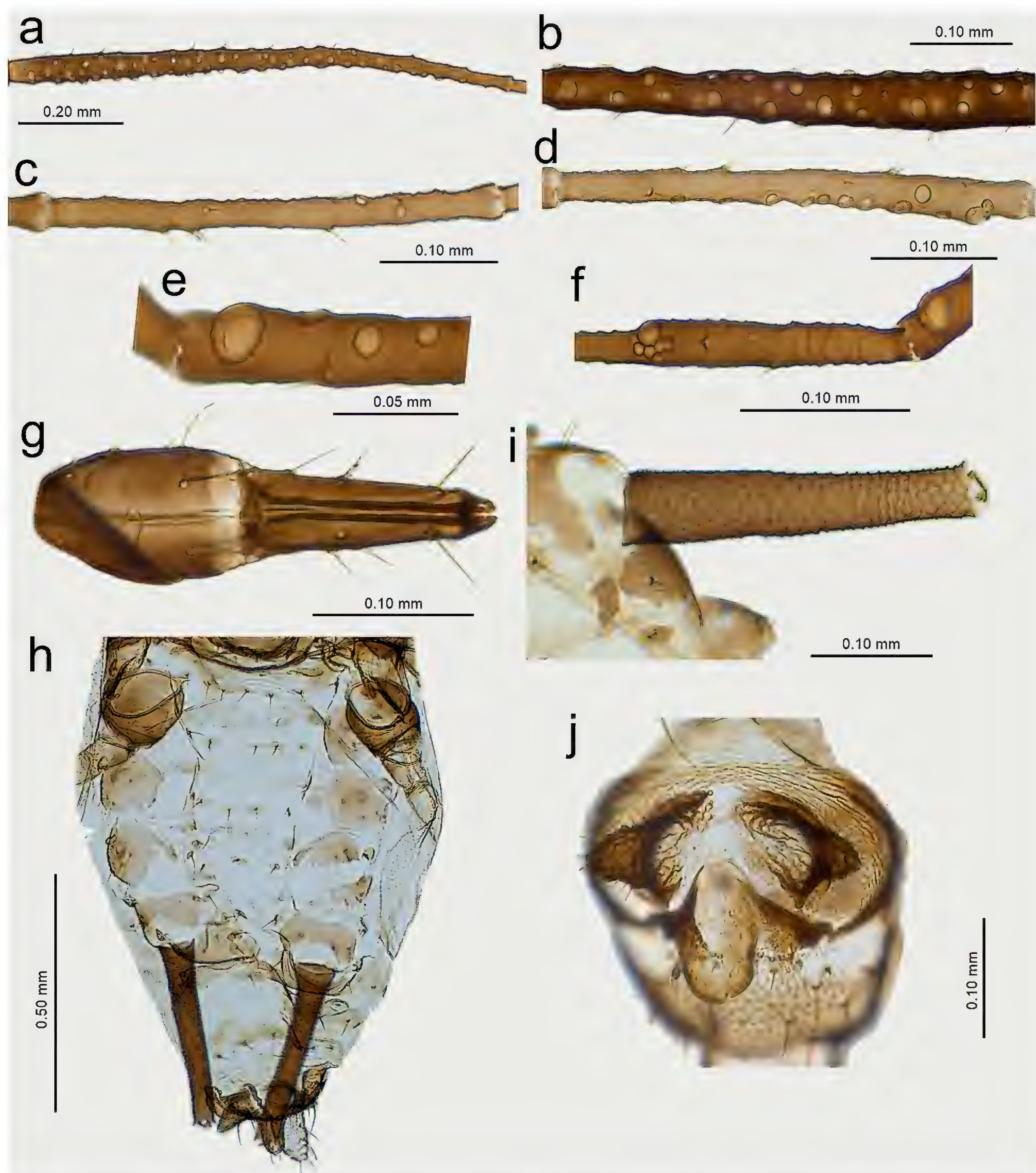


Fig. 6. Alate male of *Uroleucon formosanum*, morphological details. **a.** ANT III secondary rhinaria distribution. **b.** Secondary rhinaria structure. **c.** ANT IV secondary rhinaria distribution. **d.** ANT V secondary rhinaria distribution. **e.** Structure of primary rhinaria on ANT V. **f.** Primary rhinaria on ANT VI. **g.** Third and ultimate rostral segments. **h.** Abdomen. **i.** Siphunculus. **j.** Genitalia.

Uroleucon (Uroleucon) fuchuense (Shinji, 1942)
Figs 3, 7–9

Macrosiphum fuchuensis Shinji, 1942: 4
Dactynotus (Dactynotus) fuchuense Takahashi, 1962:75

Uroleucon fuchuense Eastop & Hille Ris Lambers, 1976:
258

Apterous viviparous females of *U. fuchuense* are characterised by a shiny salmon red to reddish brown colour in life with dark antennae, distal halves of femora, dark tib-

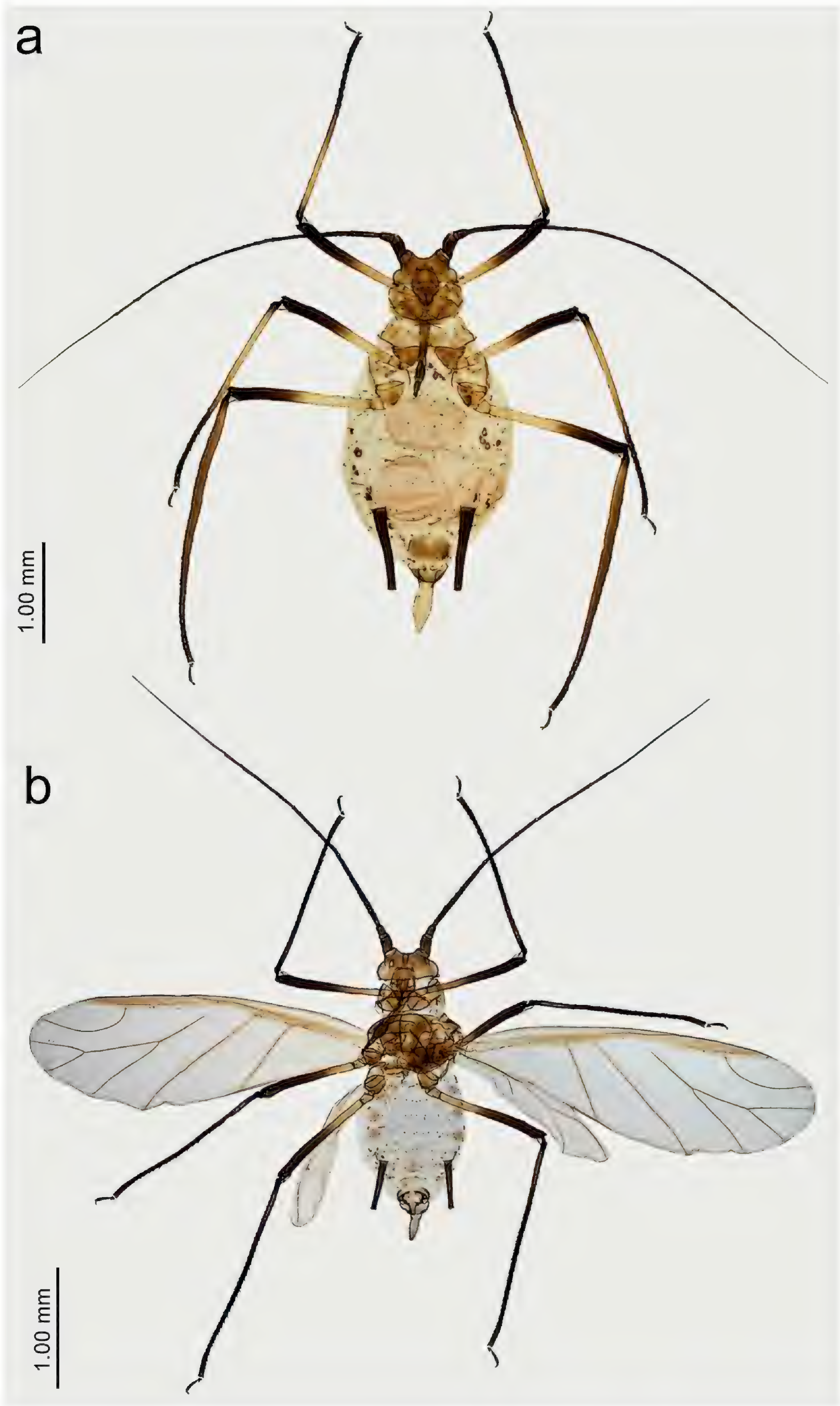


Fig. 7. Sexual morphs of *Uroleucon fuchuense*. **a.** Oviparous female. **b.** Alate male.

iae and pale cauda (Fig. 3d). Although this poorly known species is similar to *U. monticola* (Takahashi, 1935) due to the presence of a row of short, peg-like setae on the hind tibiae, it can be distinguished from it by ANT III with more than 20 secondary rhinaria, the SIPH only slightly longer than the cauda which has more than 35 setae. The species is known from Korea (Lee et al. 2002b; Choi 2019), Japan (Shinji 1941; Miyazaki 1971) and the Russian Far East (Pashchenko 1988, 2000, 2001). Miyazaki (1971) collected many apterous and alate viviparous females from *Aster scaber*. It has also been included in the review of the *Uroleucon* of Korea by Lee et al. (2002b) and *A. scaber* and *Lactuca raddeana* are the host plants. In the Russian Federation, *U. fuchuense* is known from Kamchatka and the Primorsky Krai (Pash-

chenko 2001; Pashchenko & Lobkova 1990). Although Pashchenko (2001) provided a detailed redescription of an apterous and alate viviparous female, the sexual generation was still unknown.

Oviparous female – description (n = 8)

Figs 7–8

Colour in life. Unknown. Pigmentation on slide: head brown; ANT uniformly brown with only slightly paler PT and sometimes slightly paler base of ANT III; pronotum and mesonotum usually sclerotised, brown; femora of legs yellow with dark brown distal halves; fore and middle tibiae yellow to light brown in proximal half, knee areas and distal halves dark brown; hind tibi-

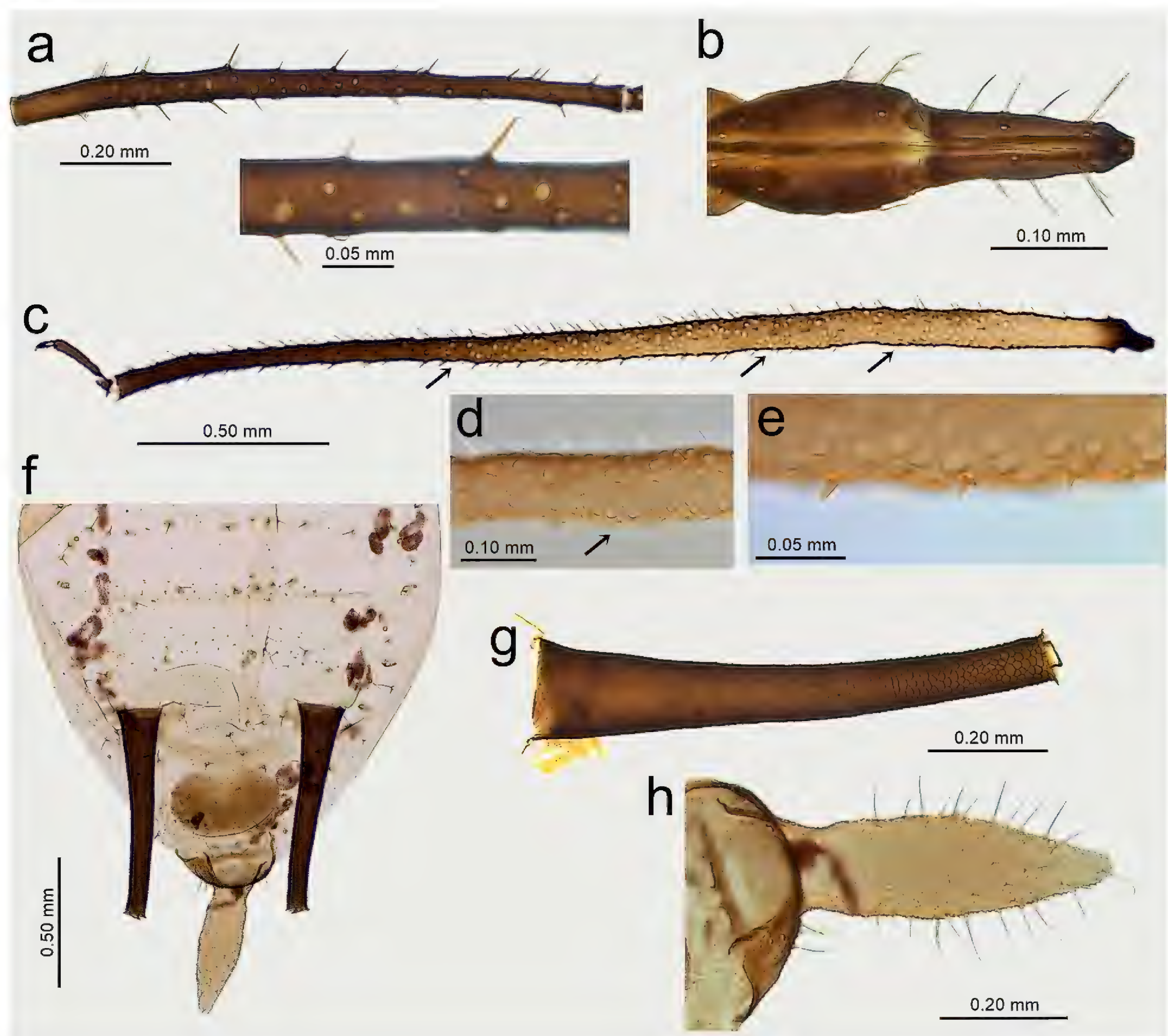


Fig. 8. Oviparous female of *Uroleucon fuchuense*, morphological details. **a.** ANT III secondary rhinaria. **b.** Third and ultimate rostral segments. **c.** Hind tibia with scent plaques and a peg-like setae distribution (arrows). **d.** Scent plaques, detailed view, and peg-like setae location (arrow). **e.** Peg-like setae, detailed view. **f.** Abdomen. **g.** Siphunculus. **h.** Cauda.

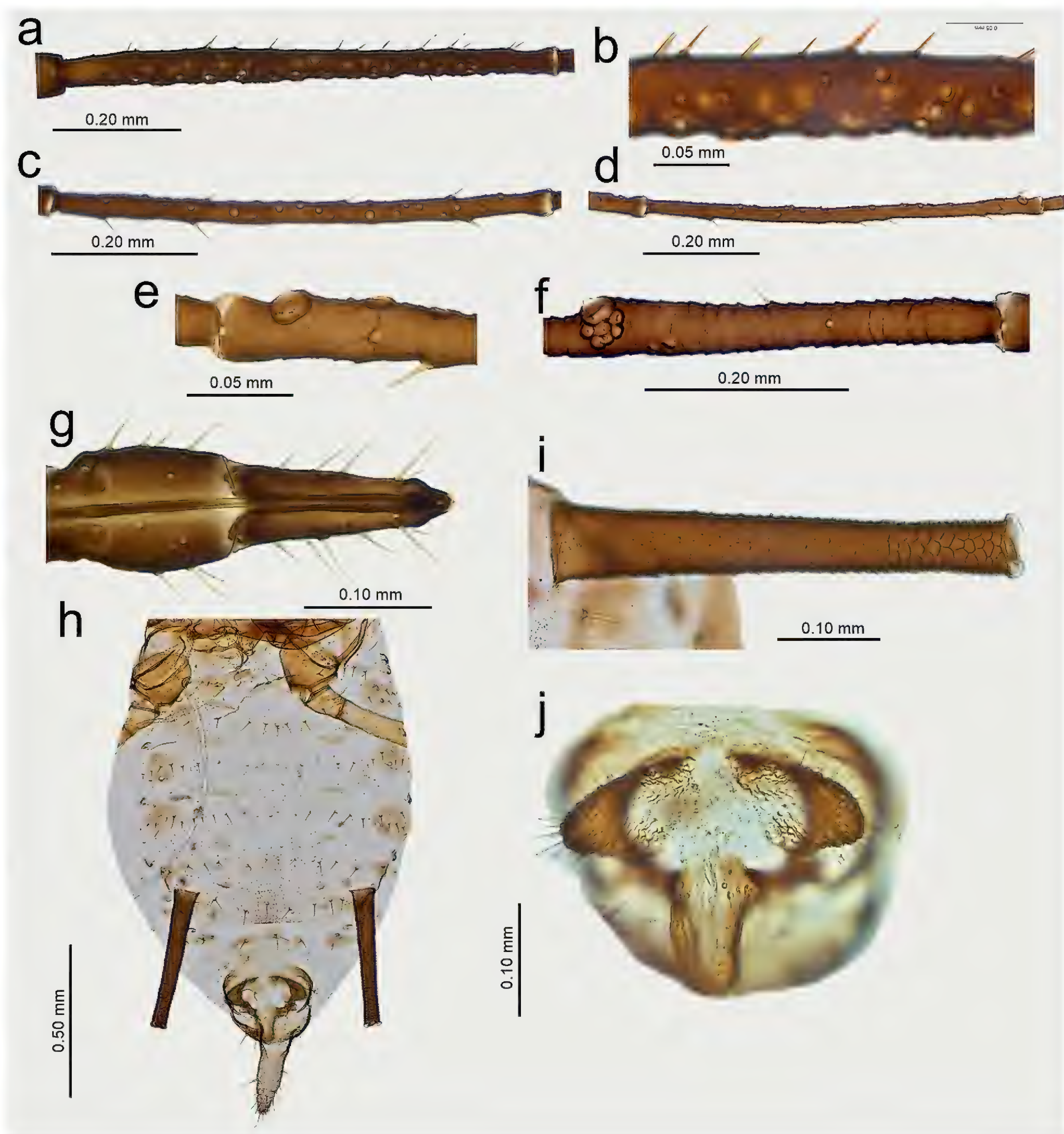


Fig. 9. Alate male of *Uroleucon fuchuense*, morphological details. **a.** ANT III secondary rhinaria distribution. **b.** Secondary rhinaria structure. **c.** ANT IV secondary rhinaria distribution. **d.** ANT V secondary rhinaria distribution. **e.** Primary rhinaria on ANT V. **f.** Primary rhinaria on ANT VI. **g.** Third and ultimate rostral segments. **h.** Abdomen. **i.** Siphunculus. **j.** Genitalia.

ae brown with paler proximal part and dark brown knee area and distal halves; tarsi dark brown; abdomen yellow with brown sclerites and scleroites; SIPH uniformly dark brown, cauda yellow (Fig. 7a).

BL 3.60–4.20 mm. HW 0.63–0.66 mm, $0.14\text{--}0.15 \times \text{ANT}$. Head with long, rigid setae with apices, $0.070\text{--}0.090$ mm long. ANT tubercles each with 3 setae

on internal angles. ANT 4.20–4.41 mm, $1.05\text{--}1.16 \times \text{BL}$. ANT III 1.01–1.12 mm, with 20–26 mostly round, different-sized secondary rhinaria with very well-developed sclerotised rims (Fig. 8a), ANT IV 0.73–0.76 mm, ANT V 0.71–0.73 mm. ANT VI 1.36–1.46 mm, BASE $0.20\text{--}0.24$ mm, PT 1.14–1.22 mm, $5.08\text{--}5.85 \times \text{BASE}$. Other antennal ratios: VI:III 1.26–1.34, V:III 0.64–0.72,

IV:III 0.67–0.72, PT:III 1.08–1.12, PT:IV 1.56–1.60, PT:V 1.56–1.69. ANT chaetotaxy: ANT has thick, rigid setae with mostly pointed or slightly blunt apices. ANT III setae 0.025–0.060 mm long, LS ANT III $1.00\text{--}1.33 \times \text{BD III}$. ANT I with 7–9, ANT II with 3–5, ANT III with 28–33, ANT IV with 16–17, ANT V with 11–12 setae. ANT VI with 3 basal, 3 apical and 8 setae along PT. Rostrum reaching hind coxae. URS 0.17–0.19 mm, $0.16 \times \text{ANT III}$, $0.12\text{--}0.13 \times \text{ANT VI}$, $0.14\text{--}0.15 \times \text{PT}$, $0.77\text{--}0.87 \times \text{BASE}$ and $1.06\text{--}1.11 \times \text{HT II}$ with 9–10 short, fine, pointed accessory setae (Fig. 8b). Mesosternal furca fused, wide without stem. III FEMORA 1.37–1.47 mm, with medium-length, thick, rigid setae with mostly pointed or slightly blunt setae, 0.025–0.065 mm long. III TIBIAE 2.62–2.80 mm, swollen in the proximal part with large number (c. 340–363) of mostly rounded or slightly irregular scent plaques (pseudosensoria) on entire area and length (except very ends) (Fig. 8c–d). III TIBIAE have rigid setae with mostly slightly pointed apices, 0.025–0.080 mm long and a row or very minute peg-like sensilla on ventral side (Fig. 8e). HT I with 5:5:5 ventral setae, HT II 0.16–0.17 mm, $0.14\text{--}0.15 \times \text{ANT III}$, $0.11 \times \text{ANT VI}$, $0.13\text{--}0.14 \times \text{PT}$ and $0.70\text{--}0.80 \times \text{BASE}$. Abdomen membranous, with by well-visible mostly irregular scleroites in spinal, dorsal and marginal areas (Fig. 8f), without marginal tubercles with long, rigid setae with mostly pointed apices, 0.007–0.10 mm long on ABD TERG I–V and 0.075–0.12 mm long on ABD TERG VI–VIII. SIPH 0.72–0.81 mm, tubular, slightly tapering, slightly curved with distinct zone of subapical reticulation and flange (Fig. 8g). Reticulated zone $0.23\text{--}0.26 \times \text{SIPH}$. SIPH $1.20\text{--}1.22 \times \text{cauda}$, $0.19\text{--}0.20 \times \text{BL}$, and $0.71\text{--}0.72 \times \text{ANT III}$. SIPH surrounded by well-developed postsiphuncular sclerites. Genital plate with two anterior setae that are longer than the others, 10–14 median and 15–20 posterior setae. Cauda 0.59–0.66 mm long and 0.20–0.25 wide, tongue-shaped, slightly constricted near base, $2.64\text{--}2.95 \times$ its width at base and $0.15\text{--}0.17 \times \text{BL}$ with 40–44 fine setae of two lengths (Fig. 8h).

Alate male – description (n = 6).

Figs 7, 9

Colour in life. Unknown. Pigmentation on slide: head and thorax light brown to brown; ANT uniformly brown to dark brown except basal part of ANT III and ANT VI, which are usually paler; coxae brown; femora with yellow bases and brown to dark brown distal 2/3 of their length; tibiae brown with light brown to yellow section near proximal part; tarsi brown; SIPH brown; cauda pale to yellow (Fig. 7b).

2.65–3.02 mm. HW 0.56–0.59 mm, $0.14\text{--}0.16 \times \text{ANT}$. Head with medium-length, fine setae with pointed apices, 0.025–0.055 mm long. ANT tubercles each with 3 setae on internal angles. ANT 3.47–4.06 mm, $1.27\text{--}1.44 \times \text{BL}$. ANT III 0.75–0.80, with 44–65 rounded or slightly oval,

different-sized, secondary rhinaria with well-developed sclerotised rims located on entire length but not on entire surface of segment (Fig. 9a–b), ANT IV 0.60–0.80 with 12–19 secondary rhinaria mostly in one row (Fig. 9c). ANT V 0.60–0.68 mm, with 12–17 rhinaria mostly in one row (Fig. 9d). Primary rhinaria surrounded by sclerotic rim with minute projections (Fig. 9e–f). ANT VI 1.26–1.45 mm, BASE 0.18–0.22 mm, PT 1.08–1.25 mm, $5.13\text{--}6.25 \times \text{BASE}$. Other antennal ratios: VI:III 1.53–1.68, V:III 0.75–0.80, IV:III 0.77–0.91, PT:III 1.28–1.44, PT:IV 1.56–1.58, PT:V 1.75–1.83. ANT have short or medium-length thick, rigid setae with pointed or slightly blunt apices. ANT III setae 0.015–0.045 mm long, LS ANT III $0.87\text{--}1.12 \times \text{BD III}$. ANT I with 8–9, ANT II with 4–5, ANT III with 25–32, ANT IV with 12–15, ANT V with 9–10 setae. ANT VI with 3–4 basal, 3–4 apical and 5–7 setae along the PT. Rostrum reaching meso or metasternum. URS 0.17–0.18 mm, $0.19\text{--}0.22 \times \text{ANT III}$, $0.12\text{--}0.13 \times \text{ANT VI}$, $0.14\text{--}0.15 \times \text{PT}$, $0.77\text{--}0.94 \times \text{BASE}$ and $1.17\text{--}1.21 \times \text{HT II}$ with 9–11 fine, pointed accessory setae (Fig. 9g). III FEMORA 1.05–1.17 mm, bearing short to medium-length, rigid setae with pointed apices, 0.010–0.055 mm long. III TIBIAE 2.05–2.30 mm, bearing thick, rigid setae with pointed apices, 0.030–0.065 mm long. HT I with 5:5:5 ventral setae, HT II 0.14–0.15 mm, $0.15\text{--}0.18 \times \text{ANT III}$, $0.10\text{--}0.11 \times \text{ANT VI}$, $0.12 \times \text{PT}$ and $0.63\text{--}0.77 \times \text{BASE}$. Abdomen membranous, with very few scleroites (Fig. 9h), small marginal tubercles on marginal sclerites on ABD II–IV (which can be poorly visible in some specimens) and with long and fine setae with pointed apices, 0.035–0.060 mm long on ABD TERG I–V and 0.050–0.080 mm long on ABD TERG VI–VIII. ABD VIII with 4 setae. SIPH 0.44–0.46 mm, tubular, straight with distinct zone of subapical reticulation and small but well-visible flange (Fig. 9i). The reticulated zone $0.21\text{--}0.26 \times \text{SIPH}$. SIPH $1.48\text{--}1.55 \times \text{cauda}$, $0.16\text{--}0.16 \times \text{BL}$, and $0.51\text{--}0.60 \times \text{ANT III}$. SIPH surrounded by ante- and postsiphuncular sclerites. Cauda 0.29–0.31 mm long and 0.12–0.16 mm wide, tapering, without constriction, $1.93\text{--}2.41 \times$ its width at base and $0.09\text{--}0.10 \times \text{BL}$, with 18–24 fine, pointed setae of two lengths. Parameres robust, subtriangular in ventral, slightly flattened in ventrolateral side, with rounded tips, covered by with numerous short, fine, pointed setae. Basal part of the phallus not longer than the parameres with numerous sensilla (Fig. 9j).

Material examined. REPUBLIC OF KOREA, Gyeonggi-do, Pocheon-si, Gwangneung Royal Tomb Arboretum, 19 October 2000, *Aster scaber*, J. Holman leg., 1 alate male, 00Ho79-80 (IECA), 1 alate male, 00Ho79-80 (IECA), 1 alate male, 00Ho79-80 (IECA), 1 alate male, 00Ho79-80 (IECA), 1 alate male, 00Ho79-80 (IECA), 1 alate male, 00Ho79-80 (IECA), 1 oviparous female, 1 apterous viviparous female, 00H079-80 (IECA), 1 oviparous female, 1 apterous viviparous female, 00H079-80

(IECA), 2 oviparous females, 00H079-80 (IECA), 2 oviparous females, 00H079-80 (IECA), 2 oviparous females, 00H079-80 (IECA).

Acknowledgements. We are sincerely grateful to Aleš Bezděk (Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic) for his kind assistance and support during the visits to the collection as well as for the loan of the many slides. Special thanks also go to Prof. Colin Favret (Montréal University, Canada), Prof. Shin-Ichi Akimoto (Hokkaido University, Sapporo, Japan), Dr. Masakazu Sano (Hokkaido Agricultural Research Center, Japan) and Dr. Andrey Stekolshchikov (Russian Academy of Sciences, Russia) for access to many papers and translations of papers on East Palaearctic *Uroleucon* species. We would like to thank JADAM Organic Farming (Daejeon, Republic of Korea) for access and permission to use the photos of live *U. formosanum* apterous viviparous females and Prof. Hyojoong Kim (Kunsan National University, Republic of Korea) for photos of alate viviparous females of *U. formosanum* and apterous viviparous female of *U. fuchuense*. Mariusz Kanturski gratefully acknowledges the Scholarship for Outstanding Young Scientists from the Ministry of Science and Higher Education of Poland (1165/E-340/STYP/12/17).

REFERENCES

- Adachi S, Yoshitomi H (2012) [Aphids of Ehime Prefecture, Shikoku, Japan (Hemiptera, Aphididae)]. Bulletin of Ehime Prefectural Science Museum 17: 29–47 (in Japanese)
- Adachi S, Yoshitomi H (2013) [Aphids of Ehime Prefecture, Shikoku, Japan (Hemiptera, Aphididae) II]. Bulletin of Omogo Mountain Museum 5: 11–22
- Blackman RL (2010) Aphids – Aphidinae (Macrosiphini). Handbooks for the Identification of British Insects 2 (7): 1–414
- Blackman RL, Eastop VF (2020) Aphids of the World's Plants: An Online Identification and Information Guide. Online at <http://www.aphidsonworldsplants.info> [last accessed 15 July 2020]
- Choi H (2019) Molecular Phylogeny of Macrosiphini (Hemiptera: Aphididae): Taxonomic
- Notes on the Two Genera *Myzus* and *Uroleucon* in the Korean Peninsula. A thesis for the degree of doctor of philosophy. Department of Agricultural Biotechnology, Seoul National University
- Choi H, Lee W, Lee S (2012) Taxonomic review of the subgenus *Uroleucon* (*Uromelan*) (Hemiptera: Aphididae) in the Korean peninsula. Journal of Asia-Pacific Entomology 15: 17–20
- Choi H, Kim H, Lee W, Lee S. (2019) The genus *Uroleucon* (Hemiptera: Aphididae) in the Korean Peninsula, with descriptions of two new species. Journal of Asia-Pacific Entomology 22: 481–486
- Depa Ł, Kanturski M, Junkiert Ł, Wieczorek K (2015) Giant females vs dwarfish males of the genus *Stomaphis* Walker (Hemiptera: Aphididae) – an aphid example of the ongoing course to permanent parthenogenesis? Arthropod Systematics and Phylogeny 73 (1): 19–40
- Eastop VF, Hille Ris Lambers D (1976) Survey of the World's Aphids. W. Junk, The Hague
- Favret C (2020) Aphid Species File. Version 5.0/5.0. Online at <http://Aphid.SpeciesFile.org> [last accessed 15 July 2020]
- Ghosh MR, Ghosh AK, Raychaudhuri DN (1970) Studies on the aphids (Homoptera : Aphididae) from Eastern India. Oriental Insects 4 (4): 377–393
- Heie OE (1995) The Aphidoidea (Hemiptera) of Fennoscandia and Denmark VI. Family Aphidinae: Part 3 of tribe Macrosiphini of subfamily Aphidinae, and family Lachnidae. Fauna entomologica scandinavica 31: 1–222
- Higuchi H, Miyazaki M (1969) A tentative catalogue of host plants of Aphidoidea in Japan. Insecta Matsumurana. Supplement 5: 1–66
- Holman J (2009) Host Plant Catalog of Aphids, Palaearctic Region. Springer Science + Business Media B.V., Berlin, Heidelberg
- Ilharco FA (1965) On the sexual morphs of *Israelaphis tavaresi* Ilharco. Agronomia Lusitana, XXVI (1): 65–69
- Ilharco FA, van Harten A (1987) Systematics. Pp. 51–78 in: Minks, AK & Harrewijn P (eds) Aphids: their biology, natural enemies and control. Elsevier Science Publishers, Amsterdam
- Kanturski M, Akbar S-A, Favret C (2017) The Bhutan pine aphid *Pseudessigella brachychaeta* Hille Ris Lambers (Hemiptera: Aphididae: Lachninae) from India reveals the hitherto unknown oviparous female and dwarfish male. Zoological Studies 56 (12): 1–17. <https://doi.org/10.6620/ZS.2017.56-12>
- Kanturski M, Lee Y, Choi J, Lee S (2018) First record of *Lachnus chosoni* (Hemiptera: Aphididae: Lachninae) in the Republic of Korea with description of sexual morphs. Zoological Studies 57 (20): 1–10. <https://doi.org/10.6620/ZS.2018.57-20>
- Lee S, Holman J, Havelka J (2002a) Illustrated Catalogue of Aphididae in the Korean Peninsula Part I, Subfamily Aphidinae. (Insects of Korea Ser. 9). Korea Research Institute of Bioscience and Biotechnology. Deajon, Korea. <https://doi.org/10.1016/j.aspen.2019.01.003>
- Lee S, Holman J, Havelka J (2002b) The genus *Uroleucon* (Hemiptera: Aphididae) from the Korean Peninsula. Part I. The Nominotypical subgenus *Uroleucon* with descriptions of three new species. Oriental Insects 6 (1): 59–77. <https://doi.org/10.1080/00305316.2002.10417322>
- Lou H (1935) Recherches sur la faune aphidologique de la Chine. Thèses Présentées à la Faculté des Sciences de l'Université de Lyon 86: 1–124
- Mier Durante MP, Ortego J, Von Dohlen CD, Nieto Nafria JM (2020) A further contribution to the knowledge of *Uroleucon* species (Hemiptera, Aphididae) living on Adesmia (Fabaceae) in southern South America, with description of a new species from Chile. Zooaxa 4748 (3): 548–560
- Miller RH, Odechiil O, Footitt, RG, Pike KS (2003) *Uroleucon formosanum* (Homoptera: Aphididae) found on *Youngia japonica* on Guam and Rota in the Mariana Islands. Proceedings of the Hawaiian entomological Society 36: 125–127
- Miyazaki M (1971) A revision of the tribe Macrosiphini of Japan (Homoptera: Aphididae, Aphidinae). Insecta Matsumurana 34 (1): 1–247
- Mordvilko AK (1914) Insectes Hémiptères (Insecta Hemiptera). I. Aphidodea. Faune de la Russie et des pays limitrophes fondée principalement sur les collectionnes du Musée Zoologique de l'Académie Impériale des Sciences de Petrograd Livraison 1: I-CLXIV, 1–236, 1–9

- Nowińska A, Mróz E, Depa Ł (2017) Sexual morphs of *Pterocomma tremulae* Börner, 1940 (Aphididae, Aphidinae) with description of male reproductive system. *ZooKeys* 686: 125–136. <https://doi.org/10.3897/zookeys.686.14493>
- Okamoto H, Takahashi R (1927) Some Aphididae from Corea. *Insecta Matsumurana* 1 (3): 130–148
- Pashchenko NF (1988) [Suborder Aphidinea – aphids]. Pp. 546–686 in: Lehr PA (ed.) [Keys to the Identification of Insects of the Soviet Far East] Vol. 2, Homoptera and Heteroptera. ‘Nauka’, Leningrad, (in Russian)
- Pashchenko NF (2000) Aphids of the genus *Uroleucon* Mordvilko, 1914 (Homoptera, Aphididae) of the Russian Far East. I. Keys to subgenera and to the species of the nominotypical subgenus, descriptions of new taxa. *Entomologicheskoe Obozrenie* 79 (4): 835–850
- Pashchenko NF (2001) [Aphids of the genus *Uroleucon* from the Russian far east: II (Homoptera, Aphididae) subgenera *Uroleucon* s. str. and *Lambersius*] *Entomologicheskoe obozrenie* 80(1): 835–850 (in Russian).
- Pashchenko NF, Lobkova LE (1990) [On the fauna of aphids (Homoptera, Aphidinea) of Kamchatka]. *News of insect systematics of the Soviet Far East* 21: 5–27
- Pike KS, Footitt RG, Miller RH, Idechiil O, Allison DW (2005) *Uroleucon formosanum* (Takahashi) and *Uroleucon sonchellum* (Monell) (Homoptera, Aphididae) Morphological comparison and diagnosis. *Proceedings of the Hawaiian entomological Society* 37: 49–63
- Pérez Hidalgo N, VanDegehuchte ML, Schütz M, Risch AC (2016). Description of the sexuales of *Myzodius modestum* (Hottes) (Homoptera: Aphididae) discovered in the Swiss Alps. *Zootaxa* 4196(4): 589–596. <https://doi.org/10.11646/zootaxa.4196.4.8>
- Shinji O (1941) [Monograph of Japanese Aphididae.] Shinkyo Sha Shoin, Tokyo (in Japanese)
- Shinji O (1942) New species of *Macrosiphum* from Tokio. *The Insect World* 46 (9): 2–7
- Sorin M (1992) [A list of Aphididae of Niigata Prefecture, Japan (1)]. *Transactions of the Essa Entomological Society of Niigata* 74: 1–7 (in Japanese)
- Sorin M, Arakawa A (2005) [A list of Aphididae of Niigata Prefecture, Japan (3)]. *Transactions of the Essa Entomological Society of Niigata* 92: 1–21 (in Japanese)
- Stekolshchikov AV, Buga S (2017) The taxonomic status of *Aphis rostellum* (Zhang, Chen, Zhong & Li, 1999) and description of the fundatrix and sexual morphs of *Aphis umbrellae* (Börner, 1950) (Homoptera: Aphidoidea). *Zootaxa* 4347 (3): 543–552
- Szelegiewicz H (1968) Notes on some aphids from Vietnam, with description of a new species (Homoptera, Aphidodea). *Annales Zoologici* 25 (12): 459–471
- Takahashi R (1921) Aphididae of Formosa, Part 1. Report of the Department of Agriculture Government Research Institute Formosa 20: 1–97
- Takahashi R (1923) Aphididae of Formosa, Part 2. Report of the Department of Agriculture Government Research Institute Formosa 4: 1–173
- Takahashi R (1924) Aphididae of Formosa, Part 3. Report of the Department of Agriculture Government Research Institute Formosa 10: 1–121
- Takahashi R (1930) Some Aphididae of Loochoo. *Transactions of the Natural Society of Formosa* 20: 317–327
- Tao CC (1963) Revision of Chinese Macrosiphinae (Aphididae, Homoptera). *Plant Protection Bulletin (Taiwan)* 5 (3): 162–205
- Tao CC (1968) Aphid fauna of China. *Science Yearbook of the Taiwan Museum* 11: 1–55
- The Plant List (2020) Version 1.1. Published on the internet. Online at <http://www.theplantlist.org/> [last accessed 15 July 2020]
- Wieczorek K, Kanturski M, Junkiert Ł (2013) *Shenahweum minutum* (Homoptera: Aphidoidea: Drepanosiphinae) – taxonomy position and sexuales description. *Zootaxa* 3731 (3): 324–330
- Wieczorek K, Plachno BJ, Świątek P (2011) Comparative morphology of the male genitalia of Aphididae (Insecta, Homoptera) part 1. *Zoomorphology* 130: 289–303
- Yoshitomi H (2014a) [Aphidoidea of Shimane Prefecture 2]. *Bulletin of the Hoshizaki Green Foundation* 17: 297–305 (in Japanese)
- Yoshitomi H (2014b) [Aphididae of the Izu Islands]. *Rostrum* 56: 9–15
- Yoshitomi H (2015) [Aphidoidea of Shimane Prefecture 3]. *Bulletin of the Hoshizaki Green Foundation* 18: 227–285 (in Japanese)
- Yoshitomi H, Adachi S (2013) [Aphidoidea of Shimane Prefecture]. *Bulletin of the Hoshizaki Green Foundation* 16: 219–240 (in Japanese)